SUMMARY PROBLEM

(a) $\Delta H^\circ = -485.8+(-285.8)-[-288.3] = -483.3$ kJ, $\Delta S^\circ = 178.7+69.9-[148.5+205.0] = -104.9$ J/K

(b) At 25°C : $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = -483.3 \text{ kJ} - 298 \text{ K}(-0.1049 \text{ kJ/K}) = -452.0$ kJ; yes

At 4°C : $\Delta G^\circ = -483.3 \text{ kJ} - 277 \text{ K}(-0.1049 \text{ kJ/K}) = -454.2$; yes

(c) At boiling, $\Delta G^\circ = 0 = \Delta H_{vap} - T_b(\Delta S^\circ) = 24.3 - (273 + 118.5)(\Delta S^\circ)$; $\Delta S^\circ = 62.1$ J/K

(d) $\Delta S^\circ = S^\circ_{CH_3COOH(g)} - S^\circ_{CH_3COOH(l)}$; $62.1 = S^\circ_{CH_3COOH(g)} - 159.8$

$S^\circ_{CH_3COOH(g)} = 221.9 \text{ J/mol} \cdot \text{K}$

(e) $\Delta G = \Delta G^\circ + RT \ln \dfrac{[CH_3COOH]}{[C_2H_5OH]P_{O_2}} = -452.0 + 0.00831(298) \ln \dfrac{0.200}{0.125 \times 1.13} = -451.1$ kJ

(f) $CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$ $K_a = 1.8 \times 10^{-5}$

$\Delta G^\circ = -RT \ln K = -0.00831(298) \ln(1.8 \times 10^{-5}) = 27.1$ kJ

PROBLEMS

1. C

3. a and b

5. a, c and d

7. (a) $H_2O(l)$ (b) C (diamond) (c) $Cl_2(l)$

9. (a) + (b) + (c) + (d) +

11. (a) − (b) − (c) − (d) +

13. (a) + (b) − (c) −

15. a < b < d < c

17. (a) ΔS° = 126.8 J/K − [197.6 J/K + 2(130.6) J/K] = −332.0 J/K

(b) ΔS° = 2(210.7 J/K) − [191.5 J/K + 205.0 J/K] = +24.9 J/K

(c) ΔS° = 70.4 J/K + 213.6 J/K − 112.1 J/K = +171.9 J/K

(d) ΔS° = 2(51.5 J/K + 223.0 J/K) − [2(72.1) J/K + 202.7 J/K] = −20.9 J/K

19. (a) ΔS° = 223.0 J/K + 2(111.3) J/K $-$ [2(56.5) J/K + 116.1 J/K] = +216.5 J/K

(b) ΔS° = [$-$73.2 + 248.1 + 2(69.9)] J/K $-$ (20.1 + 51.8) J/K = +242.8 J/K

(c) ΔS° = [152.2 + 2($-$10.8)] J/K $-$ [2(82.4) + 2(69.9)] J/K = $-$43.4 J/K

21. (a) ΔS° = [2(188.7) + 2(248.1)] J/K $-$ [2(205.7) + 3(205.0)] J/K = $-$152.8 J/K

(b) ΔS° = [240.0 + 69.9 + 72.4] J/K $-$ [42.6 + 146.4] J/K = + 193.6 J/K

(c) ΔS° = [$-$128.9 + 248.1 + 2(69.9)] J/K $-$ (29.9 + 20.1) J/K = 209.0 J/K

23. ΔG° = $-$362 kJ $-$318 K(0.0192 kJ/K) = $-$368 kJ

ΔG° = 745 kJ $-$318 K(0.113 kJ/K) = +709 kJ

ΔG° = $-$22.5 kJ $-$318 K($-$0.0992 kJ/K) = +6.8 kJ

25. (a) ΔH° = $-$ 238.7 kJ + 110.5 kJ = $-$128.2 kJ

ΔG° = $-$128.2 kJ + 355 K(0.3320 kJ/K) = $-$10.3 kJ ; spontaneous

(b) ΔH° = +180.4 kJ

ΔG° = 180.4 kJ – 355 K(0.0249 kJ/K) = +171.6 kJ ; nonspontaneous

(c) ΔH° = $-$553.5 kJ $-$393.5 kJ + 1216.3 kJ = +269.3 kJ

ΔG° = 269.3 kJ $-$ 355 K(0.1719 kJ/K) = +208.3 kJ ; nonspontaneous

(d) ΔH° = $-$1147.2 kJ + 822.4 kJ = $-$324.8 kJ

ΔG° = $-$324.8 kJ $-$ 355 K($-$0.0209 kJ/K) = $-$317.4 kJ ; spontaneous

27. (a) [2($-$51.6)] kJ $-$ [2($-$131.2)] kJ = +159.2 kJ

(b) [$-$77.6 + ($-$300.2) + 2($-$237.2)] kJ $-$ ($-$744.5) kJ = $-$107.7 kJ

(c) [2($-$157.2)] kJ $-$ [2($-$104.0) + 2($-$237.2)] kJ = +368.0 kJ

29. (a) ΔH° = $-$391.5 kJ

ΔS° = +0.1153 kJ/K $-$0.0518 kJ/K $-$0.2230 kJ/K = $-$0.1595 kJ/K

ΔG_f° = $-$391.5 kJ $-$ 298 K($-$0.1595 kJ/K) = $-$344.0 kJ

(b) $\Delta H^\circ = -238.7$ kJ

ΔS° = +0.1268 kJ/K $-$ 0.0057 kJ/K $-$ 0.2612 kJ/K $-$ 0.1025 kJ/K = $-$ 0.2426 kJ/K

$\Delta G_f^\circ = -238.7$ kJ $-$ 298 K($-$ 0.2426 kJ/K) = $-$ 166.4 kJ

(c) $\Delta H^\circ = -79.5$ kJ

ΔS° = +0.1209 kJ/K $-$ 0.0664 kJ/K $-$ 0.0318 kJ/K = +0.0227 kJ/K

$\Delta G_f^\circ = -79.5$ kJ $-$ 298 K(0.0227 kJ/K) = $-$ 86.3 kJ

31. $CH_3OH(l) \rightarrow CH_4(g) + \frac{1}{2} O_2(g)$

$\Delta G^\circ = (\Delta G_f^\circ\ CH_4) + \frac{1}{2}(\Delta G_f^\circ\ O_2) - (\Delta G_f^\circ\ CH_3OH)$ = ($-$ 50.7 + 0 + 166.3) kJ = +115.6 kJ; no

33. (a) $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$; 34.6 kJ = 135.6 kJ $-$ (298 K)ΔS° ; ΔS° = 0.339 kJ/K

yes; increase in the number of moles of gas

(b) At 0 K: $\Delta G^\circ = \Delta H^\circ$ = +135.6 kJ

At 1000 K: ΔG° = 135.6 kJ $-$ 1000 K(0.339 kJ/K) = $-$ 203 kJ

35. (a) $\Delta S^\circ = \dfrac{\Delta H^\circ - \Delta G^\circ}{T} = \dfrac{[-82.4 - (-219.8)]\text{ kJ}}{298\text{ K}}$ = +0.461 kJ/K

yes; increase in the number of moles of gas

(b) +0.461 kJ/K = 2(+0.1607 kJ/K) + 2(0.2136 kJ/K) $- S^\circ\ C_6H_{12}O_6(aq)$; $S^\circ\ C_6H_{12}O_6(aq)$ = +0.288 kJ/K

(c) $-$ 82.4 kJ = 2[($-$ 277.7) + 2($-$ 393.5)]kJ $- \Delta H_f^\circ\ C_6H_{12}O_6(aq)$; $\Delta H_f^\circ\ C_6H_{12}O_6(aq) = -1260.0$ kJ

37. (a) $\Delta S^\circ = \dfrac{\Delta H^\circ - \Delta G^\circ}{T} = \dfrac{[-353.2 - (-452.4)]\text{ kJ}}{298\text{ K}}$ = +0.333 kJ/K

yes; increase in the number of moles of gas

(b) +0.333 kJ/K = 2($S^\circ\ COCl_2$) + 2(+0.1868 kJ/K) $-$ [2(0.2017) + 0.2050] kJ/K ; $S^\circ\ COCl_2$ = +0.284 kJ/K

(c) $-$ 353.2 kJ = 2($\Delta H_f^\circ\ COCl_2$) + 2($-$ 92.3) kJ –[2(–134.5)] kJ ; $\Delta H_f^\circ\ COCl_2 = -218.8$ kJ

39. (a) $\Delta H > 0$, $\Delta S > 0$; spontaneous at (very) high temperatures

(b) $\Delta H < 0$, $\Delta S < 0$; spontaneous at low temperatures

(c) $\Delta H > 0$, $\Delta S < 0$; nonspontaneous

41. (a) $T = \dfrac{\Delta H}{\Delta S} = \dfrac{830.8 \text{ kJ}}{0.168 \text{ kJ/K}} = 4950$ K; nonspontaneous below ≈ 5000 K

(b) $T = \dfrac{\Delta H}{\Delta S} = \dfrac{-1643 \text{ kJ}}{-0.316 \text{ kJ/K}} = 5200$ K; spontaneous below 5200 K

(c) Calculation gives a *negative* T.

43. $\Delta H^\circ = 2(-121.6 \text{ kJ}) - [2(-167.2)] \text{ kJ} = 91.2 \text{ kJ}$

$\Delta S^\circ = [0.2230 + 2(0.0824)] \text{ kJ/K} - [2(0.0565) + 0.1522] \text{ kJ/K} = 0.1226 \text{ kJ/K}$

$0 = 91.2 \text{ kJ} - T(0.1226) \text{ kJ/K}$; T = 744 K

45. (a) $\Delta H^\circ = [3(-393.5)] \text{ kJ} - [2(-824.2)] \text{ kJ} = +467.9 \text{ kJ}$

$\Delta S^\circ = [4(0.0273 + 3(0.2136] \text{ kJ/K} - [2(0.0874) + 3(0.0057)] \text{ kJ/K} = 0.5581 \text{ kJ/K}$

$\Delta G^\circ = 467.9 \text{ kJ} - T(0.5581) \text{ kJ/K}$

T (K)	100	200	300	400	500
ΔG° (kJ)	412.1	356.3	300.5	244.7	188.9

(b) $0 = 467.9 \text{ kJ} - T(0.5581 \text{ kJ/K})$; $T = 838$ K. Since ΔH° and $\Delta S^\circ > 0$, 838 K is the lowest T.

47. For: $Fe_2O_3(s) + \frac{3}{2} C(s) \rightarrow 2 Fe(s) + \frac{3}{2} CO_2(g)$

$\Delta H^\circ = \frac{3}{2}(-393.5 \text{ kJ}) - (-824.2) \text{ kJ} = +234.2 \text{ kJ}$

$\Delta S^\circ = [2(0.0273) + \frac{3}{2}(0.2136)] \text{ kJ/K} - [0.0874 + \frac{3}{2}(0.0057)] \text{ kJ/K} = +0.2790 \text{ kJ/K}$

$0 = 234.2 \text{ kJ} - T(0.2790) \text{ kJ/K}$; $T = 839$ K

For: $Fe_2O_3(s) + 3 H_2(g) \rightarrow 2 Fe(s) + 3 H_2O(g)$

$\Delta H^\circ = 3(-241.8) \text{ kJ} - (-824.2) \text{ kJ} = +98.8 \text{ kJ}$

$\Delta S^\circ = [2(0.0273) + 3(0.1887)] \text{ kJ/K} - [0.0874 + 3(0.1306)] \text{ kJ/K} = +0.1415 \text{ kJ/K}$

$0 = 98.8 \text{ kJ} - T(0.1415) \text{ kJ/K}$; $T = 698$ K

The reaction with $H_2(g)$ is sppontaneous at lower temperature.

49. red P $\rightleftharpoons$ white P

$\Delta H^\circ = 0.00 \text{ kJ} + 17.6 \text{ kJ} = +17.6 \text{ kJ}$; $\Delta S^\circ = 0.04109 \text{ kJ/K} - 0.02280 \text{ kJ/K} = +0.01829 \text{ kJ/K}$

$T = (17.6 \text{ kJ})/(0.01829 \text{ kJ/K}) = 962$ K

51. rhombic $\rightleftharpoons$ monoclinic

ΔH° = +0.30 kJ ; ΔS° = 0.0326 kJ/K $-$ 0.0318 kJ/K = +0.0008 kJ/K

T = (0.30 kJ)/(0.0008 kJ/K) $\approx$ 400 K

53. Na(s) $\rightleftharpoons$ Na(g)

ΔH° = +108.7 kJ ; ΔS° = +0.1024 kJ/K ; T = (108.7 kJ)/(0.1024 kJ/K) = 1062 K

55. $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2\,Cl^-(aq)$

ΔG° = [$-$24.4 + 2($-$131.2)] kJ $-$ ($-$314.1) kJ = 27.3 kJ

(a) $\Delta G = \Delta G^\circ + RT \ln[Pb^{2+}][Cl^-]^2$ = 27.3 kJ + (0.00831 kJ/K)(298 K) ln (1.00)(2.0)^2 = 30.7 kJ

nonspontaneous

(b) ΔG = 27.3 kJ + (0.00831 kJ/K)(298 K) ln $(1.0 \times 10^{-5})(2.0 \times 10^{-5})^2 = -54.8$ kJ

spontaneous

57. (a) ΔG° = [2($-$157.2)] kJ $-$ [2($-$237.2) + 2($-$131.2)] kJ = 422.4 kJ

(b) ΔG = +422.4 kJ + (0.00831 kJ/K)(298 K) ln $\dfrac{(0.250)^2(9.5 \times 10^{-3})^2}{(0.335)^2}$ = 397.9 kJ

59. (a) ΔG° = [2($-$371.1)] kJ $-$ [2($-$300.2)] kJ = $-$141.8 kJ

(b) 1.0 kJ = $-$141.8 kJ + (0.00831 kJ/K)(298 K) ln $\dfrac{(0.400)^2}{(0.400)^2 P_{O_2}}$; $P_{O_2} = 9 \times 10^{-26}$ atm

61. (a) ΔH° = $-$393.5 kJ + 241.8 kJ + 110.5 kJ = $-$41.2 kJ

ΔS° = (+0.2136 + 0.1306 $-$ 0.1887 $-$0.1976) kJ/k = $-$0.0421 kJ/K

ΔG° = $-$41.2 kJ $-$ ($-$0.0421 kJ/K)(825 K) = $-$6.5 kJ

(b) $\ln K = -\dfrac{\Delta G^\circ}{RT} = -\dfrac{-6.5}{(0.00831\ \text{kJ/K})(825\ \text{K})}$; K = 2.6

63. (a) $\Delta G^\circ = -RT \ln K$ = $-$(0.00831 kJ/K)(298 K) ln(1.0×10^{-37}) = 211 kJ

(b) 211 kJ = 2(ΔG_f° Cl (g)) ; ΔG_f° Cl (g) = 106 kJ

65. at 473 K: $\Delta G^\circ = -(0.00831 \text{ kJ/K})(473 \text{ K}) \ln(2.2 \times 10^{11}) = -103 \text{ kJ}$

at 533 K: $\Delta G^\circ = -(0.00831 \text{ kJ/K})(533 \text{ K}) \ln(4.6 \times 10^{8}) = -88.3 \text{ kJ}$

67. $BaSO_4(s) \rightarrow Ba^{2+}(aq) + SO_4^{2-}(aq)$

$\Delta G^\circ = -560.8 \text{ kJ} - 744.5 \text{ kJ} + 1362.3 \text{ kJ} = +57.0 \text{ kJ}$

$57.0 \text{ kJ} = -(0.00831 \text{ kJ/K})(298 \text{ K}) \ln K$; $K = 1 \times 10^{-10}$; K_{sp} value is 1.1×10^{-10}

69. At equilibrium: $[H^+] = 10^{-4.57} = 2.7 \times 10^{-5} M$; $[HX] = 0.218 - 2.7 \times 10^{-5} = 0.218 M$

$$K_a = \frac{[H^+][X^-]}{[HX]} = \frac{(2.7 \times 10^{-5})^2}{0.218} = 3.3 \times 10^{-9}$$

$\Delta G^\circ = -RT \ln K = -(0.00831 \text{ kJ/K})(298 \text{ K}) \ln(3.3 \times 10^{-9}) = 48 \text{ kJ}$

71.

$SO_2(g) + 3\,CO(g) \rightarrow COS(g) + 2\,CO_2(g)$	$\Delta G^\circ = -246.5 \text{ kJ}$
$2\,H_2(g) + 2\,CO_2(g) \rightarrow 2\,CO(g) + 2\,H_2O(g)$	$\Delta G^\circ = +57.0 \text{ kJ}$
$SO_2(g) + CO(g) + 2\,H_2(g) \rightarrow COS(g) + 2\,H_2O(g)$	$\Delta G^\circ = -189.5 \text{ kJ}$

73. (a) $\Delta G^\circ = -32.9 \text{ kJ} - [2(-50.7) \text{ kJ}] = 68.5 \text{ kJ}$; nonspontaneous

(b)

$2\,CH_4(g) \rightarrow C_2H_6(g) + H_2(g)$	$\Delta G^\circ = +68.5 \text{ kJ}$
$H_2(g) + \frac{1}{2}\,O_2(g) \rightarrow H_2O(g)$	$\Delta G^\circ = -228.6 \text{ kJ}$
$2\,CH_4(g) + \frac{1}{2}\,O_2(g) \rightarrow C_2H_6(g) + H_2O(g)$	$\Delta G^\circ = -160.1 \text{ kJ}$ spontaneous

75. 31 kJ/mol ATP ; $372 \text{ kJ} \times \frac{1 \text{ mol ATP}}{31 \text{ kJ}} = 12 \text{ mol}$

77. (a) $P_{CO} = 0.9831(1.00 \text{ atm}) = 0.983 \text{ atm}$; $P_{CO_2} = 1.000 - 0.0983 = 0.017 \text{ atm}$

(b) $K = \frac{(P_{CO})^2}{P_{CO_2}} = \frac{(0.983)^2}{0.017} = 57$

(c) $\Delta G^\circ = -RT \ln K = -(0.00831 \text{ kJ/K})(1200 \text{ K}) \ln 57 = -40 \text{ kJ}$

79. (a) $PbCl_2(s) \rightarrow Pb^{2+}(aq) + 2\,Cl^-(aq)$

ΔH° = [− 1.7 + 2(− 167.2)] kJ − (− 359.4 kJ) = 23.3 kJ

ΔS° = [0.0105 + 2(0.0565] kJ/K − 0.1360 kJ/K = − 0.0125 kJ/K

ΔG° = 23.3 kJ − (298 K)(− 0.0125 kJ/K) = 27.0 kJ

$[Pb^{2+}] = [PbCl_2] = 0.030\ M$; $[Cl^-] = 2[Pb^{2+}] = 2(0.030) = 0.060\ M$

ΔG = 27.0 kJ + (0.00831 kJ/K)(298 K) ln[(0.030)(0.060)^2] = 4.4 kJ ; not possible at 25°C

(b) ΔG° = 23.3 kJ − (373 K)(− 0.0125 kJ/K) = 28.0 kJ

ΔG = 28.0 kJ + (0.00831 kJ/K)(373 K) ln[(0.030)(0.060)^2] = − 0.30 kJ ; yes (just barely)

81. ΔG° = [− 368.57 + 3(− 237.2)] kJ − [2(− 50.7) + (− 16.5)] kJ = − 926.3 kJ ; spontaneous at 25°C

(b) $\Delta G^\circ = -RT\ln K$; $-926.3 = -(0.00831\ kJ/K)(298\ K)\ln K$; $K = e^{374}$

The equilibrium constant is very large, thus very favorable.

(c) Calculations for K or ΔG° do not imply rate.

83. (a) $\Delta G^\circ = -RT\ln K = -(0.00831\ kJ/K)(298\ K)\ln(3.6 \times 10^8) = -49\ kJ$

(b) The reaction as written is spontaneous; $\rightarrow$

(c) $\Delta G = -49\ kJ + (0.00831\ kJ/K)(298\ K)\ln\dfrac{0.010}{(0.0010)(3.5 \times 10^{-4})^4} = 36\ kJ$

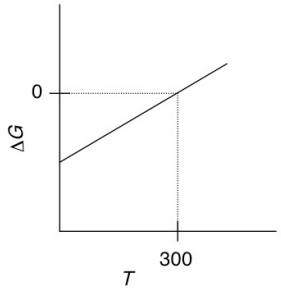
85. (a) independent of T, P (b) independent of T

(c) dependent on both T, P (b) dependent on T, P

87. (a) 0 (b) + (c) the normal melting point

89. (a) F (b) T (c) T (d) F (e) F (f) T

91. $\Delta G = 0$ at 300 K ΔH and ΔS are both less than zero.



93. $\Delta H^\circ = T\Delta S^\circ$ = (351.5 K)(0.2827 − 0.1607) kJ/K = 42.9 kJ

$$\ln \frac{760}{357} = \frac{42.9 \text{ kJ}}{0.00831 \text{ kJ/mol} \cdot \text{K}} \left(\frac{1}{T} - \frac{1}{352 \text{ K}} \right); \quad T = 335 \text{ K} = 62^\circ\text{C}$$

94. ΔH° = 62.4 kJ − 53.0 kJ = +9.4 kJ

ΔS° = 0.2607 kJ/K + 0.1306 kJ/K − 0.4130 kJ/K = −0.0217 kJ/K

ΔG° = 9.4 kJ − (773 K)(−0.0217 kJ/K) = 26.2 kJ

$$\ln K = \frac{26.2 \text{ kJ/mol}}{(0.00831 \text{ kJ/mol} \cdot \text{K})(773 \text{ K})}; \quad K = 0.017; \quad 0.017 = \frac{(0.200 - x)^2}{(0.200 + 2x)^2}; \quad x = 0.14$$

$P_{H_2} = P_{I_2}$ = 0.200 − 0.14 = 0.06 atm ; P_{HI} = 0.200 + 2(0.14) = 0.48 atm

95. (a) ΔH° = (18.0 g/mol)(0.333 kJ/g) = +6.00 kJ/mol

(b) 0

(c) ΔS° = 6.00 kJ/273 K = 0.0220 kJ/K

(d) ΔG° = +6.00 kJ − (0.0220 kJ/K)(253 K) = +0.44 kJ

(e) ΔG° = +6.00 kJ − (0.0220 kJ/K)(293 K) = −0.44 kJ

96. (a) ΔS° = +140 kJ/298 K = +0.470 kJ/K

At 37°C: ΔG° = −5650 kJ − (310 K)(0.470 kJ/K) = −5800 kJ

$$w = 1.00 \text{ g} \times \frac{1 \text{ mol}}{342 \text{ g}} \times \frac{5800 \text{ kJ}}{1 \text{ mol}} \times 0.25 = 4.2 \text{ kJ}$$

(b) w = (0.00979)(120/2.20)(4158) = 2.22×10^3 kJ

$$\text{mass} = \frac{2.2 \times 10^3 \text{ kJ}}{4.2 \text{ kJ/g}} = 5.3 \times 10^2 \text{ g}$$

97. $CaH_2(s) \rightarrow Ca(s) + H_2(g)$ $\quad \Delta H^\circ = +186.2$ kJ

ΔS° = +0.0414 kJ/K + 0.1306 kJ/K $-$ 0.0420 kJ/K = +0.1300 kJ/K

$$T = \frac{186.2 \text{ kJ}}{0.1300 \text{ kJ/K}} = 1430 \text{ K} \approx 1160^\circ\text{C}$$

98. $2\,CuO(s) \rightarrow Cu_2O(s) + \frac{1}{2}\,O_2(g)$

ΔH° = +146.0 kJ ; $\quad \Delta S^\circ$ = +0.1104 kJ/K ; $\quad T$ = 1322 K $\approx 1050^\circ$C

$Cu_2O(s) \rightarrow 2\,Cu(s) + \frac{1}{2}\,O_2(g)$

ΔH° = +168.6 kJ ; $\quad \Delta S^\circ$ = +0.0758 kJ/K ; $\quad T$ = 2220 K $\approx 1950^\circ$C

99. At 25°C: $\Delta G^\circ = -RT \ln K = -$ (0.00831 kJ/K)(298 K) ln 1.754×10^{-5} = 27.1 kJ

At 50°C: $\Delta G^\circ = -RT \ln K = -$ (0.00831 kJ/K)(323 K) ln 1.633×10^{-5} = 29.6 kJ

27.1 = $\Delta H^\circ - T\Delta S^\circ \rightarrow \Delta H^\circ$ = 27.1 + 298(ΔS°)

29.6 = $\Delta H^\circ - T\Delta S^\circ \rightarrow \Delta H^\circ$ = 29.6 + 323(ΔS°)

Since ΔH° has the same value at both temperatures:

27.1 + 298(ΔS°) = 29.6 + 323(ΔS°) ; $\quad \Delta S^\circ = -$ 0.010 kJ/mol·K

100.

	2 HI	$\rightleftharpoons$	H_2	+	I_2
P_o (atm)	0.200		0.200		0.200
ΔP (atm)	+ 0.280		$-(\frac{1}{2})$ 0.280		$-(\frac{1}{2})$ 0.280
P_{eq} (atm)	0.480		0.060		0.060

$$K = \frac{(0.06)(0.06)}{(0.48)^2} = 0.0156$$

$\Delta G^\circ = -RT \ln K = -$ (0.00831 kJ/K)(773 K) ln 0.0156 = 26.7 kJ

101. $\Delta H^\circ = 2(-46.1 \text{ kJ}) = -92.2$ kJ

ΔS° = [2(0.01923)] kJ/K $-$ [0.1915 + 3(0.1306)] kJ/K = $-$ 0.1987 kJ/K

When K = 1, ΔG° = 0

0 = $-$ 92.2 kJ $-$ ($-$ 0.1987 kJ/K)(T) $\quad T$ = 464 K